Tanta University | Department: Computer and Control Engineering | Faculty of Engineering
Total Marks: 90 Marks

Course Title: Signals and Systems	Course Code: CCE2210	Year: 2nd
Date: June 9th 2012 (Second term)	Allowed time: 3 hrs	No. of Pages: (2)

Remarks: (Answer the following questions)

Problem number (1) (15 Marks)

a) Define the following terms **[10 Marks]**

(i) System order and system type
(ii) Dynamic and static systems
(iii) Open-loop and closed-loop systems
(iv) Stable and unstable systems
(v) Time-variant and time-invariant systems

b) Express the signal $x(t)$ shown in Figure 1 in terms of impulse and/or step and/or ramp functions. **[5 Marks]**

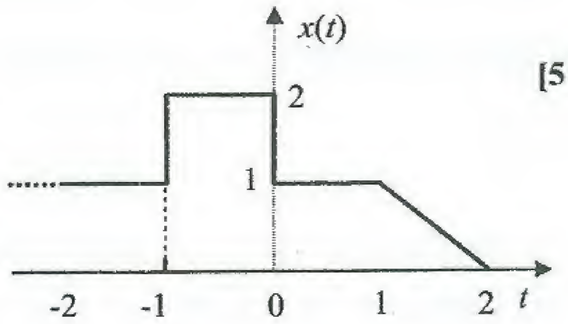

Figure 1

Problem number (2) (20 Marks)

a) For the system shown in Figure 2, **[10 Marks]**

(i) Find the differential equations,
(ii) Draw the block diagram, then,
(iii) Find the transfer function ($I_2(s)/E_i(s)$).

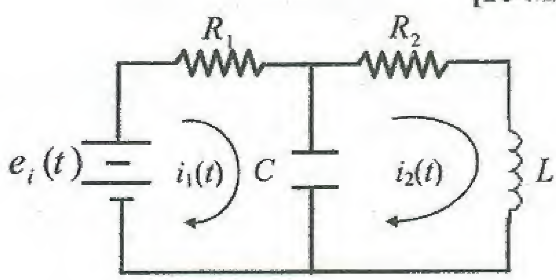

Figure 2

b) Find the overall transfer function (Y(s)/X(s)) of the system that has the signal flow graph shown in Figure 3. **[10 Marks]**

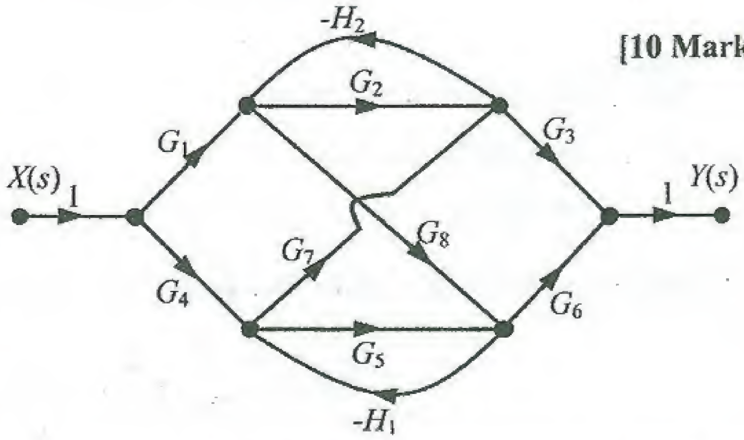

Figure 3

Problem number (3) (15 Marks)

a) Check the stability and the causality of the systems with the impulse responses of: **[8 Marks]**

$$(i)\ h_1(t) = e^{-t}u(t-2)$$

$$(ii)\ h_2(t) = e^{t}u(t-1)$$

b) The characteristic equation of a linear control system is given as **[7 Marks]**

$$s(s^3 + 2s^2 + s + 1) + K(s + 1) = 0$$

Apply the Routh-stability criterion to determine the values of K for system stability.

Problem number (4) (20 Marks)

a) A pair of complex-conjugate poles in the s-plane is required to meet the various specifications that follow. For each specification, sketch the region in the s-plane in which the poles should be located. **[6 Marks]**

(i) $\zeta \geq 0.707$ $\quad\omega_n \geq 2$ rad/sec

(ii) $0 \leq \zeta \leq 0.707$ $\quad\omega_n \leq 2$ rad/sec

(iii) $\zeta \leq 0.5$ $\quad 1 \leq \omega_n \leq 5$ rad/sec

b) A position control system has the **closed loop** transfer function given by **[14 Marks]**

$$\frac{Y(s)}{U(s)} = \frac{25}{s^2 + 4s + a}$$

(i) Find the parameter a for critically damped stable system.

(ii) Determine the parameter a for steady state error (e_{ss}) to a unit step input equal to zero.

(iii) If $a = 20$, find

- The rise time
- The settling time t_s for 2% tolerence
- The overshoot MOS
- The Peak time t_p

Problem number (5) (20 Marks)

a) For the following system **[12 Marks]**

$$\dot{x}(t) = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} x(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t)$$

$$y(t) = \begin{bmatrix} 1 & 1 \end{bmatrix} x(t)$$

Find,

(i) The state transition matrix.

(ii) The transfer function.

(iii) The response of the system $y(t)$ for initial condition $x(0) = [\,1 \;\; 0\,]^T$ and zero input.

b) For the system that have the following transfer function **[8 Marks]**

$$\dot{x}(t) = \begin{bmatrix} -1 & 0 \\ -3 & -3/2 \end{bmatrix} x(t) + \begin{bmatrix} 2 \\ 2\beta \end{bmatrix} u(t)$$

$$y(t) = \begin{bmatrix} 1 & 2\alpha \end{bmatrix} x(t)$$

Calculate

(i) for what values of α and β is the system controllable.

(ii) for what values of α and β is the system observable.

GOOD LUCK

Dr. Ali Abu Tahoun